BIOGEOMON 9th International Symposium on Ecosystem Behavior, August 20th to 24th 2017 in Litomyšl, Czech Republic

Small insect – great repercussions

Effects of *Lymantria monacha* L. outbreaks on forest N cycling

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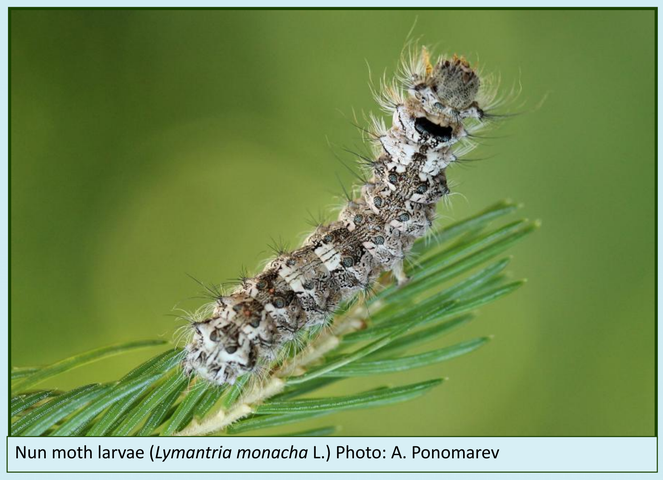
Aims

To characterize **effects of insect mass outbreaks**
(1) on soil N fluxes
(2) on (in)organic N acquisition strategies of Scots pine and
(3) on compensatory processes in the N nutritional status of fine roots and needles.

Background

- Changing climatic conditions favor spread, intensity and duration of pest insect populations.
- These mass outbreaks of defoliating pest insects alter nitrogen cycling in forest ecosystems.

Objective: Quantification of N fluxes in the soil and consequences for N nutrition of Scots pine during mass outbreaks of *L. monacha.*



Nun moth larvae (*Lymantria monacha* L.) Photo: A. Ponomarev

Methods

(1) Soil N Fluxes:
- Throughfall
- Dry matter input (feces, litter)
- Soil perlocats (with zero tension humus lysimeters underneath humus layer)

(2) ^{15}N Uptake:
- Fine roots were incubated in four artificial soil solutions, where one N form (NH_4^+, NO_3^-, Glutamine, Arginine) was labled with ^{15}N as described in Simon et al. (2010)

Net N uptake capacity measurement on still attached fine Roots of Scots pine. Photo: M. Grüning

(3) N metabolites:
Determination of
- total soluble protein-N,
- total amino acid-N,
- ammonium-N,
- nitrate-N and
- structural N

contents in fine roots and needles of infested and control Scots pine.

Results and conclusion

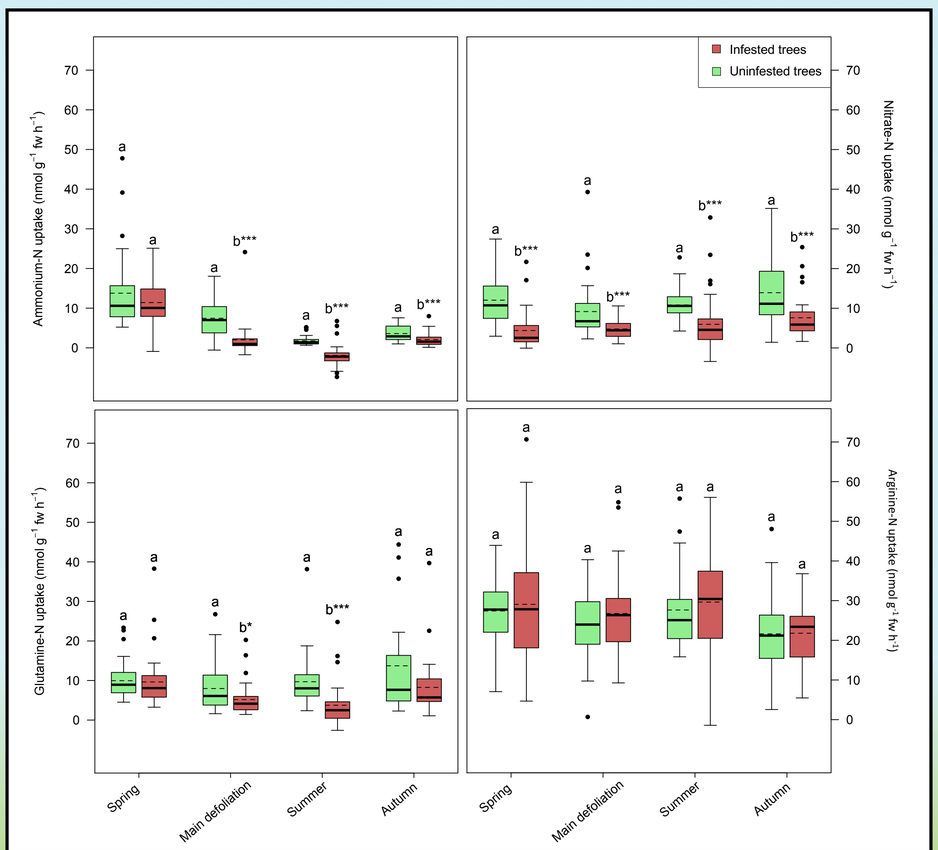
21% — Increased total N in infested needles during main defoliation and thereof **72% increased total soluble protein N**

(3) → Compensatory response to nun moth infestation

96% — Average increase of total N input (litter + feces + throughfall) during mass outbreak years of L. *monacha*

(1) Increased soil N availability but
(2) inhibited (in)organic **N acquisition:**

growth
defense
recovery



Inorganic and organic N uptake capacity (nmol g^{-1} fw h^{-1}) of with nun moth infested and control pine forests. C: control site, I: infested site, Spr: „spring", MD: „main defoliation", Sum: „summer", Aut: „autumn". Box plots show means (dotted lines) and medians (straight lines; n = 36 for each treatment). Different small letters indicate significant differences between infested and control plots in one season ($p \leq 0.050$). Asterisks indicate level of significance (***p <0.001, **p<0.010, *p<0.050).

30 - 65% — Reduction of inorganic and glutamine-N uptake capacity of infested Scots pine fine roots

45% — Higher total N in soil solution compared to uninfested sites

22% — Average increase of total N in fine roots, thereof **70% increased total amino acid N concentration during main defolition**

(3) → Reallocation from internal sources to maintain N nutrition

For more details see: Grüning MM, Simon J, Rennenberg H and I-M-Arnold A (2017) Defoliating Insect Mass Outbreak Affects Soil N Fluxes and Tree N Nutrition in Scots Pine Forests. Frontiers in Plant Science. 8:954.